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FOODBORNE AND WATERBORNE DISEASE OUTBREAKS: A Compilation and Subjective Profile

Thomas V. Murphy, M.B.A.

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Final Report for Period January 1977 - June 1983

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USAF SCHOOL OF AEROSPACE MEDICINE
Aerospace Medical Division (AFSC)
Brooks Air Force Base, TX 78235-5301

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This report has been reviewed and is approved for publication.

THOMAS V. MURPHY, M.B.A.
Project Scientist

ALTON J. RAHE, M.S.
Supervisor

ROYCE MOSER, Jr.
Colonel, USAF, MC
Commander

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This paper provides the epidemiologic field with a single source of information about many confirmed foodborne and waterborne disease outbreaks for each of five common bacterial etiologies: *Staphylococcus aureus*, *Salmonella*, *Shigella*, *Clostridium perfringens*, and *Vibri parahaemolyticus*. The paper also evaluates traditional methods of outbreak reporting and suggests how an investigator might apply information of past outbreaks to help form an initial, presumptive diagnosis of a most probable etiologic agent in a current outbreak.

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CONTENTS

List of Illustrations

Figure

List of Tables

Table

FOODBORNE AND WATERBORNE DISEASE OUTBREAKS: A COMPILATION AND SUBJECTIVE PROFILE

INTRODUCTION

To my knowledge, the epidemiologic literature lacks a summary reference that contains, for each of five well-known bacterial etiologies, available facts of many confirmed foodborne and waterborne disease outbreaks. One goal of this report is to fill this void.

Furthermore, a clinician investigating a foodborne or waterborne outbreak faces the need to make an early, presumptive diagnosis to guide his initial medical actions. Another goal of this report is to address this need.

The five bacterial etiologies addressed in this report--*Staphylococcus aureus*, *Salmonella*, *Clostridium perfringens*, and *Vibrio parahaemolyticus*--were chosen for three reasons. First, their outbreaks often involve a large number of cases and thus lend themselves to quantifiable description. Second, they usually account for most of the confirmed outbreaks reported during a given year. For example, in the 3-year period 1974-1976, they collectively added up to between 80% and 90% annually of the reported total (1, p.9). Third, the symptom complexes associated with outbreaks caused by these agents lack the unique and consistent marker symptoms that often characterize such etiologies as *Clostridum botulinum* (neurological disorders), heavy metal poisonings (metallic taste), and various fish-related poisonings (paresthesia in lips, tongue, or extremities; flushing; urticaria). This absence of marker symptoms increases the difficulty of making an early, presumptive diagnosis of the etiology.

PROCEDURE

An extensive literature search was conducted to establish a reference file. Sources examined include a computerized search of references in Index Medicus for the period 1966-1977, the Morbidity and Mortality Weekly Report of the Center for Disease Control (CDC) for the period 1962-1979, and unpublished reports of Air Force outbreaks.

Certain criteria were established for accepting outbreaks into the reference file. Specifically, each description of an outbreak had to contain three elements: 1) Only one etiologic agent was responsible for the outbreak, 2) laboratory confirmation of the etiology was based on guidelines prescribed by CDC (1, pp.47-51), and 3) a quantifiable symptom complex was presented. Most of the outbreaks reviewed did not contain a quantifiable symptom complex; rather, the observed complex was reported in qualitative terms with descriptive adjectives such as "many," "most," "few," "some," and "characterized by."

FINDINGS

Table 1 presents a summary of the usable data collected and shows, for each etiology, 1) the number of outbreaks meeting the acceptance criteria, 2) the total number of persons whose illness was diagnosed as belonging to the given etiology, and 3) the number of ill persons in all outbreaks reporting yes or no for each of eight selected symptoms. The table reveals three important points. First, I could locate only a few *Shigella* outbreaks in which water was the vehicle of transmission. This small group accounts for only 10% of all collected outbreaks. Second, the number of symptoms reported in an outbreak varies widely. This can be seen in Table 1 where the number of ill persons reporting on a symptom (yes or no) is less than the total number of persons with etiology diagnosed. (Of the 70 outbreaks in the reference file, only 12 (17%) reported information on all eight listed symptoms.) Third, information about combinations of symptoms is not reflected in the table. Without exception, whenever a quantifiable symptom complex was given, reported frequencies were restricted to each symptom separately. For example, the percent ill who vomited was normally reported, as was the percent ill who had diarrhea. However, the percent ill who experienced both vomiting and diarrhea was never mentioned. Such omissions have important consequences regarding statistical analysis of the data. This point is further developed in the Discussion section.

TABLE 1. DATA AVAILABLE FROM PAST OUTBREAKS

	Etiology					
	Staphylococcus aureus	*Salmonella*	*Shigella* (Foodborne)	*Shigella* (Waterborne)	*C. perfringens*	*V. parahaemolyticus*
No. usable outbreaks (70)	14	22	8	7	12	7
Total ill persons interviewed (etiology diagnosed)	2122	2321	973	1107	688	871
Total ill persons reporting yes or no for following symptoms:						
Fever/Feverishness	260	2309	973	1107	404	871
Nausea	758	2154	838	1000	623	799
Vomiting	2122	2249	960	1107	623	871
Diarrhea	2114	2321	973	1107	688	871
Abd cramps	2063	2318	851	1107	688	871
Headache	1452	1677	804	1017	477	871
Chills	155	1554	823	841	294	785
Bldy stool	0	625	340	918	223	472

Tables 2-7, organized by etiology, are each divided into two parts and illustrate in detail each outbreak in the reference file. Part A of these tables shows the symptom complex and the number of ill people interviewed (etiology diagnosed); part B continues with an incubation period, the vehicle of transmission, the particular strain of the responsible etiologic agent where relevant, and the reference source. The frequency and haphazard location of missing information in the symptom complexes (part A, Tables 2-7) reinforce my finding that many inconsistent methods of reporting symptoms still exist. For nearly all symptoms within any given etiology, high variability in the presence of a symptom across outbreaks is observed regardless of how consistently that symptom is reported. Reasons for such variation might include 1) the virulence of different strains or types of an etiologic agent, 2) the amount of affected food or water ingested, and 3) the small size of some outbreaks. Table 8 highlights this variability by showing, for each symptom across all etiologies, the range of reported percentages, the number of outbreaks from which the reported range is taken, and the number of outbreaks which did not report that symptom.

Tables 1-8 show that, within any given etiology, not all outbreaks were reported with equal precision. Moreover, the information that was reported fails to describe relationships between observed symptoms.

With these data limitations in mind, a composite profile of the symptom complex for each etiology was created to aid in forming an early diagnosis. The average percentage ill was computed for each symptom in a given etiology. Since the quality of data being collected from outbreak to outbreak was impossible to assess, the percentage from each outbreak contributed equally to the computation of this average. Likewise, due to the inconsistent quality of the data, outbreaks with missing information about a symptom were, for the most part, omitted from the calculation of that symptom's average. A few unreported symptoms, however, were assumed to be zero for certain etiologies and so were included in the average. Table 9 shows the basis for these assumptions. It presents the clinical manifestations that are, according to three standard medical references (2,3,4), either associated with or absent from each of the included etiologies. The following synopsis summarizes the information in these tables: "In considering the bacterial diarrheas, it is useful to divide them into two groups, those caused by invasive and those caused by noninvasive microorganisms. The invasive pathogens...generally cause abdominal pain, fever, and other systemic symptoms, often including headache and myalgia. Illness caused by the noninvasive pathogens...is generally characterized by the absence of fever and few systemic symptoms (except those directly related to intestinal fluid loss). The invasive pathogens characteristically destroy gut mucosal cells, typically involving the terminal ileum and colon, so that both leukocytes and erythrocytes are present to a variable degree in the stool. Inflammatory cells are generally absent from the stool in acute diarrheal disease caused by noninvasive bacterial pathogens." (5) Tables 2-7 (part A) reflect agreement with this synopsis. Systemic symptoms and bloody stool are reported less frequently in the noninvasive pathogens of *Staphylococcus aureus* and *Clostridium perfringens*. In accordance with the literature, then, I have assumed zero values for any unreported fever or bloody stool in outbreaks of noninvasive etiologic agents.

TABLE 2. USABLE OUTBREAKS WITH ETIOLOGY OF *Staphylococcus aureus*

Part A

Date of outbreak	Symptom complex (percent ill)								Total ill people interviewed
	Fever/feverishness	Nausea	Vomiting	Diarrhea	Abd cramps	Headache	Chills	Bldy stools	
Jul 1962	25	94	88	88	75	31	38		16
Oct 1962		89	79	71	75				28
Jan 1966		100	100	100					37
Jul 1967		100	100	100					22
Mar 1968			70	19	71	41			1364
Mar 1971	7	100	100	100	58	6	46		72
Mar 1973	50	75	60	70	72				96
Jul 1973	25	76	43	67	72		25		67
Feb 1975		68	82	88	74				197
Sep 1975		100	100		100				8
Nov 1975		94	97	98	51				126
Jun 1976		94	88	69	81				16
May 1978	0	78	67	100	56				9
Mar 1979		74	85	39	61				64

Part B

	Incubation period		Vehicle of transmission	Reference[a]
	Hours	Descriptive statistic		
Jul 1962	0-5	Range	Egg salad	MMWR 11/9/62
Oct 1962	3-6	Range	BBQ chicken	MMWR 1/11/63
Jan 1966	2-4	Range	Five food items	MMWR 3/12/66
Jul 1967	2-5	Range	Cake icing	MMWR 8/26/67
Mar 1968	1-9	Range	Chicken salad	MMWR 3/30/68
	3-6	Mode		
Mar 1971	3.5	Mean	Ham	MMWR 5/22/71
Mar 1973	0.5-5.5	Range	Potato salad	MMWR 4/21/73
	3.5	Median		
Jul 1973	1-10	Range	Macaroni salad	MMWR 8/25/73
	4.5	Mode		
Feb 1975	0.5-5.5	Range	Ham	MMWR 2/15/75
	2.5	Mean		
Sep 1975	4-5	Range	Salami	MMWR 11/1/75
Nov 1975	3	Mode	Chicken salad	MMWR 4/30/76
Jun 1976	2-3	Range	Chocolate eclairs	MMWR 10/15/76
May 1978			Potato salad	USAF EPI (Mather AFB)
Mar 1979	1.6-6.5	Range		
	3.5	Median	Chicken salad	MMWR 9/21/79

[a]MMWR: Morbidity and Mortality Weekly Report by the Center for Disease Control.
USAF EPI: Investigation by Air Force epidemiology team.

TABLE 3. USABLE OUTBREAKS WITH ETIOLOGY OF *Salmonella*

Part A

Date of outbreak	Symptom complex (percent ill)								Total ill people interviewed
	Fever/feverishness	Nausea	Vomiting	Diarrhea	Abd cramps	Headache	Chills	Bldy stools	
Sep 1962	39	35	14	88	41	23	18		285
Sep 1965	63	53	48	88	94	85	85		32
Jul 1966	83	71	52	94	90	68	74	10	106[a]
Jan 1967	100		100	100	100	100			51
Sep 1967	39	29	26	41	73	18	26		300
Mar 1968	66		62	79	55				29
Oct 1968	80	73	37	90	89				98
Jan 1969	91		27	100	73				11
Jun 1969	48	48	30	70	61				33
Aug 1969	92	84	64	98	83		88		105
Dec 1969	70	77	41	89	88				128
Jul 1970	68	53	53	87	70	36	38	4	303
Aug 1970	63			100	85	52			71
Aug 1970	79	65	54	81	79	66			112
Dec 1971	98	93	70	98	98				40
Jul 1972		100	100	100	100				10
Jun 1973	61	17	18	94	88				163
Jun 1973	62	69	40	93	86	65	61	5	120
Sep 1973	55	41	41	92	88	41	68		85
Sep 1974	90	81	65	100	84	87	84	14	105
Aug 1975	43	38	19	95	57	29			19
Aug 1975	11	44	9	77	71	34	43		115
Jul 1971[b]	100		48	67	66	79			33

[a]Not all subjects were interviewed for all symptoms in this outbreak. Total is maximum number of subjects who reported on a symptom (diarrhea); fewer subjects reported about other symptoms.

[b]This outbreak *(Salmonella typhi)* is shown for the sake of completeness and was not used in developing the composite profile.

TABLE 3 (continued)

Part B

Date of outbreak	Incubation period Hours	Descriptive statistic	Vehicle of transmission	*Salmonella* strain(s)	Reference[a]
Sep 1962	52	Median	Turkey	*typhimurium*	MMWR 12/14/62
Sep 1965			Turkey	*heidelberg/ schottmulleri*	MMWR 12/25/65
Jul 1966	27	Median	BBQ chicken	*typhimurium*	AJE 90(5),69
Jan 1967	22.5	Mean	Turkey salad	*saint paul*	MMWR 1/14/67
Sep 1967			Roast beef	*thompson*	MMWR 1/6/68
Mar 1968	29	Mean	Turkey	*bredency*	MMWR 4/6/68
Oct 1968	23	Median	Turkey	*saint paul*	MMWR 11/9/68
Jan 1969	29	Mean	Turkey	*infantis*	MMWR 2/22/69
Jun 1969	18	Mean	Roast beef	*welikada*	MMWR 8/16/69
Aug 1969	12	Mean	Whale meat	*enteritidis*	AJE 96(2),72
Dec 1969	18	Mean	Five food items	*san diego*	MMWR 3/7/70
Jul 1970	40	Mean	BBQ pork	*thompson*	MMWR 8/1/70
Aug 1970			Cornish hen	*enteritidis*	MMWR 8/22/70
Aug 1970			Turkey, meat loaf	*thompson*	MMWR 3/27/71
Dec 1971			BBQ pork	*typhimurium*	MMWR 4/3/71
Jul 1972	9.5	Mean	Ice cream	*montevideo*	MMWR 9/23/72
Jun 1973	18	Mean	Beef in gravy	*blockley*	MMWR 12/8/73
Jun 1973	12-18	Median	BBQ beef	*agona*	MMWR 8/18/73
Sep 1973	23	Median	Chicken	*infantis/ agona/ schwarzengrund*	AJE 101(6),75
Sep 1974	30	Mean	Potato salad	*newport*	AJPH 67(11),77
Aug 1975	30	Median	Roast beef	*saint paul*	MMWR 2/7/76
Aug 1975	36	Mean		*enteritidis*	USAF EPI (Vandenburg AFB)
Jul 1971[b]	432	Mean		*typhi*	MMWR 10/9/71

[a]MMWR: Morbidity and Mortality Weekly Report by the Center for Disease Control
USAF EPI: Investigation by Air Force epidemiology team
AJE: American Journal of Epidemiology
AJPH: American Journal of Public Health

[b]This outbreak *(Salmonella typhi)* is shown for the sake of completeness and was not used in developing the composite profile.

TABLE 4. USABLE OUTBREAKS WITH ETIOLOGY OF *Shigella* (Foodborne)

Part A

Date of outbreak	Symptom Complex (percent ill)								Total ill people interviewed
	Fever/feverishness	Nausea	Vomiting	Diarrhea	Abd cramps	Headache	Chills	Bldy stools	
Sep 1954	68		40	84					122
Feb 1963	85	69	51	95	91	68	55	13	75
Jan 1970	74	33	26	100	52				28
Sep 1970	79	63	28	65	47	65	79		43
May 1971	73	60	56	75	84	20	45		440
Sep 1971	53	42	32	100	95		58	5	19
Jul 1973	78	56	53	92	76	29	27	9	233
Jun 1976	46			100	46	46	38	8	13

Part B

	Incubation period		Vehicle of transmission	*Shigella* strain	Reference[a]
	Hours	Descriptive statistic			
Sep 1954	32	Median		*sonnei*	PHR 71(9),56
Feb 1963				*sonnei*	MMWR 5/24/63
Jan 1970				*sonnei*	MMWR 2/21/70
Sep 1970				*sonnei*	USAF EPI (Lackland AFB)
May 1971	24	Mean	Turkey salad	*sonnei*	MMWR 7/10/71
Sep 1971			Seafood cocktail	*sonnei*	MMWR 10/30/71
Jul 1973	21	Median	4 types of salad	*sonnei*	AJE 100(3),74
Jun 1976	64	Median		*flexneri*	MMWR 10/1/76

[a]MMWR: Morbidity and Mortality Weekly Report by the Center for Disease Control
USAF EPI: Investigation by Air Force Epidemiology team
AJE: American Journal of Epidemiology
PHR: Public Health Reports

TABLE 5. USABLE OUTBREAKS WITH ETIOLOGY OF *Shigella* (Waterborne)

Part A

Date of outbreak	Symptom complex (percent ill)								Total ill people interviewed
	Fever/feverishness	Nausea	Vomiting	Diarrhea	Abd cramps	Headache	Chills	Bldy stools	
Mar 1969	71	65	42	97	48	45			31
Nov 1972	72	65	43	76	61	77	48	9	206
Jun 1973	47	59	27	98	85	66	54	6	596
Jul 1973	46		23	98	79	54			68
Aug 1973	36	76	44	66	72				90
Jan 1974	71	73	61	100	100	63		13	77
Jul 1974	95		49	100	79	51	51	23	39
Apr 1973[a]	83			100	92			96	434

[a]This *Shigella dysenteriae* outbreak is shown for the sake of completeness and is not used in developing the composite profile.

Part B

	Vehicle of transmission	*Shigella* strain	Reference[a]
Mar 1969	Well water	*sonnei*	MMWR 5/31/69
Nov 1972	Well water	*sonnei*	AJE 101(4),75
Jun 1973	Ship's water	*flexneri*	AJE 101(2),75
Jul 1973	Well water	*sonnei*	MMWR 11/24/73
Aug 1973	Well water	*sonnei*	MMWR 11/24/73
Jan 1974	Well water	*sonnei*	AJE 103(4),76
Jul 1974	River water	*sonnei*	MMWR 11/16/74
Apr 1973[b]	Island water	*dysenteriae*	JID 7/1/75

[a]MMWR: Morbidity and Mortality Weekly Report by the Center for Disease Control
AJE: American Journal of Epidemiology
JID: Journal of Infectious Diseases

[b]This *Shigella dysenteriae* outbreak is shown for the sake of completeness and is not used in developing the composite profile.

TABLE 6. USABLE OUTBREAKS WITH ETIOLOGY OF *Clostridium perfringens*

Part A

Date of outbreak	Symptom complex (percent ill)								Total ill people interviewed
	Fever/feverishness	Nausea	Vomiting	Diarrhea	Abd cramps	Headache	Chills	Bldy stools	
Jan 1964	8	33	6	82	75	40		7	110
Oct 1966		32	12	90	85	8			73
May 1968	9	37	10	91	67	39	26	1	113
Nov 1972				100	83				35
Nov 1973		48	16	89	86				146
Apr 1974				100	100				30
Sep 1977	1	2	2	96	80	3	3		181

Part B

	Incubation period		Vehicle of transmission	Reference[a]	
	Hours	Descriptive statistic			
Jan 1964	11	Mean	Lamb stew	MMWR	7/10/64
Oct 1966	15	Median	Chicken salad	MMWR	10/18/66
May 1968	13	Mean	Prime rib	MMWR	6/22/68
Nov 1972	10	Mean	Beef stroganoff	MMWR	1/6/73
Nov 1973	14	Median	Turkey	MMWR	1/12/74
Apr 1974	10	Mean	Tenderloin tips	MMWR	11/23/74
Sep 1977	11	Mean	Bean burritos	CMR	4/21/78

[a] MMWR: Morbidity and Mortality Weekly Report by the Center for Disease Control
CMR: California Morbidity Report

TABLE 7. USABLE OUTBREAKS WITH ETIOLOGY OF *Vibrio parahaemolyticus*

Part A

Date of Outbreak	Symptom complex (percent ill)								Total ill people interviewed
	Fever/feverishness	Nausea	Vomiting	Diarrhea	Abd cramps	Headache	Chills	Bldy stools	
Aug 1971	27	71	60	100	82	42	5		106
Aug 1971	26	79	79	98	81	28	14		43
Aug 1971	29	43	71	86	79	14	7		14
Aug 1971	25	75	63	75	88	56	44		16
Aug 1971	13	50	63	100	75	13	13		8
Aug 1971	33	72	44	100	89	56	56		18
Aug 1972	43		35	93	68	36	43		72
Dec 1974	28	46	33	100	85	33	45	3	127
Feb 1975	34	63	58	100	96	46	71	5	166
Feb 1975	17	51	38	100	86	32	37	1	93
Dec 1977	6	31	33	97	66	15		2	86
Jun 1978	48	72	12	95	92	48	[illegible]		122

Part B

	Incubation period		Vehicle of transmission	Reference[a]
	Hours	Descriptive statistic		
Aug 1971	16	Median	Steamed crabs	AJE 96(6),72
Aug 1971	15	Median	Steamed crabs	AJE 96(6),72
Aug 1971	14	Median	Steamed crabs	AJE 96(6),72
Aug 1971	12	Median	Steamed crabs	AJE 96(6),72
Aug 1971	23	Median	Steamed crabs	AJE 96(6),72
Aug 1971	18	Median	Steamed crabs	AJE 96(6),72
Aug 1972	23	Median	Boiled shrimp	AJE 100(4),74
Dec 1974			Seafood cocktail	MMWR 3/22/75
Feb 1975			Shrimp cocktail	MMWR 3/22/75
Feb 1975			Lobster	MMWR 3/22/75
Dec 1977			Seafood salad	MMWR 3/3/78
Jun 1978			Boiled shrimp	MMWR 9/15/78

[a]MMWR: Morbidity and Mortality Weekly Report by the Center for Disease Control
AJE: American Journal of Epidemiology

TABLE 8. PERCENTAGE RANGE OF SYMPTOMS REPORTED WITHIN OUTBREAKS AND NUMBER OF OUTBREAKS REPORTING OR NOT REPORTING SYMPTOMS

Symptom	Etiology					
	S. aureus	*Salmonella*	*Shigella* (Foodborne)	*Shigella* (Waterborne)	*C. perfringens*	*V. parahaemolyticus*
Fever/feverishness(%)[a]	0-50	11-100	46-85	36-95	1-9	6-48
Reports[b]	5	21	8	7	3	12
No reports[c]	9	1	0	0	4	0
Nausea (%)	68-100	17-100	33-69	59-76	2-48	31-79
Reports	13	18	6	5	5	11
No reports	1	4	2	2	2	1
Vomiting (%)	43-100	9-100	26-56	23-61	2-16	12-79
Reports	14	21	7	7	5	12
No reports	0	1	1	0	2	0
Diarrhea (%)	19-100	41-100	65-100	66-100	82-100	75-100
Reports	13	22	8	7	7	12
No reports	1	0	0	0	0	0
Abd.Cramps(%)	51-100	41-100	46-95	48-100	67-100	66-96
Reports	12	22	7	7	7	12
No reports	2	0	1	0	0	0
Headache (%)	6-41	18-100	20-68	45-77	3-40	13-56
Reports	3	13	5	6	4	12
No reports	11	9	3	1	3	0
Chills (%)	25-46	18-88	27-79	48-54	3-26	5-71
Reports	3	10	6	3	2	11
No reports	11	12	2	4	5	1
Bloody Stool(%)	0	4-14	5-13	6-23	1-7	1-5
Reports	0	4	4	4	2	4
No reports	14	18	4	3	5	8

[a]Minimum and maximum percentage of those who had this etiology diagnosed.
[b]Number of outbreaks that reported information on these symptoms.
[c]Number of outbreaks that did not report information on these symptoms.

TABLE 9. CLINICAL MANIFESTATIONS ASSOCIATED WITH OUTBREAKS OF GASTROENTERITIS FOR SOME COMMON BACTERIAL PATHOGENS

(A) Noninvasive Etiologic Agents

Pathogen	Description
Staphylococcus aureus	Abdominal cramping pain with violent and often repeated retching and vomiting--Diarrhea may be profuse, mild, or absent (2, p. 65)
	Severe nausea, vomiting, cramping abdominal pain, diarrhea, and prostration--Diagnosis based partly on lack of fever (3, p. 812)
	Differs from other noninvasive bacterial diarrheas by the prominence of vomiting (4, p. 587)
Clostridium perfringens	Main features are diarrhea and griping abdominal pain--No blood or mucus in feces--Nausea and vomiting in a small proportion of patients--Unaccompanied by systemic disturbance or fever (2, pp. 65,66)
	Diarrhea with abdominal pain and cramps--Nausea occurs occasionally, but vomiting is rare--Systemic symptoms are usually absent (4, pp. 692, 693)

(B) Invasive Etiologic Agents

Salmonella	Nausea and vomiting common initial symptoms; rapidly followed by colicky abdominal pain and persistent diarrhea, occasionally with mucus or blood--Nausea and vomiting rarely severe or protracted--Initial chill not unusual--Fever of 38-39°C common (2, p. 451)
	Sudden onset of colicky abdominal pain and loose, watery diarrhea, occasionally with mucus or blood--Nausea and vomiting frequent but rarely severe or protracted--Fever of 38-39°C common--Maybe an initial chill (4, p. 647)
Shigella	Phase I (1-3 days): Cramping abdominal pain and watery diarrhea sometimes accompanied by fever (up to 40°C) and generalized myalgia; Phase II (possibly weeks): Dysentery, bright-red blood and mucus in feces--Tenesmus, anorexia, and weight loss common--Fever not prominent--Neurologic symptoms rare in adults but common in children 1-4 --Roughly 25% of hospitalized children convulse (2, p. 458)
	First symptom often abdominal pain followed within an hour by high fever and diarrhea, often accompanied by tenesmus--Nausea, vomiting, headache, myalgia, and convulsions in children--Stools liquid and greenish in color with shreds of mucus, and in 20-30% of cases various amounts of gross blood--Profound dehydration and circulatory collapse may occur (4, p. 649)

TABLE 9 (Continued)

Pathogen	Description
Vibrio parahaemolyticus	Severe diarrhea accompanied by cramping abdominal pain, nausea, and vomiting--Fever, chills, and headache in many patients--Dysenteric form of illness with fever and bloody stool less common (2, p. 66) Acute diarrhea with moderately severe abdominal cramps possibly prominent--Volume of fluid loss generally not great--chills and fever in roughly half the cases--Vomiting generally not prominent feature, occurring in no more than one-third of patients (4, p. 677)

Table 10 lists the computed average percentages for each symptom over all etiologies, again assuming zero values for any unreported fever or bloody stool in outbreaks of noninvasive etiologic agents. Plots of these averages are given in Figures 1-6, which display the resulting profiles associated with each etiologic agent.

TABLE 10. AVERAGE PERCENTAGES OF PATIENTS REPORTING SYMPTOMS[a]

Symptom	Etiology					
	Staphylococcus aureus	*Salmonella*	*Shigella* (Foodborne)	*Shigella* (Waterborne)	*C. perfringens*	*V. parahaemolyticus*
Fever/feverishness	8	67	70	63	3	27
Nausea	88	60	54	68	30	59
Vomiting	83	46	41	41	9	49
Diarrhea	78	89	89	91	93	95
Abd cramps	70	80	70	75	82	82
Headache	26	54	46	59	23	35
Chills	36	59	51	51	15	35
Bldy stool	0	8	9	13	1	3

[a]Used to create symptom profiles (Figs. 1-6).

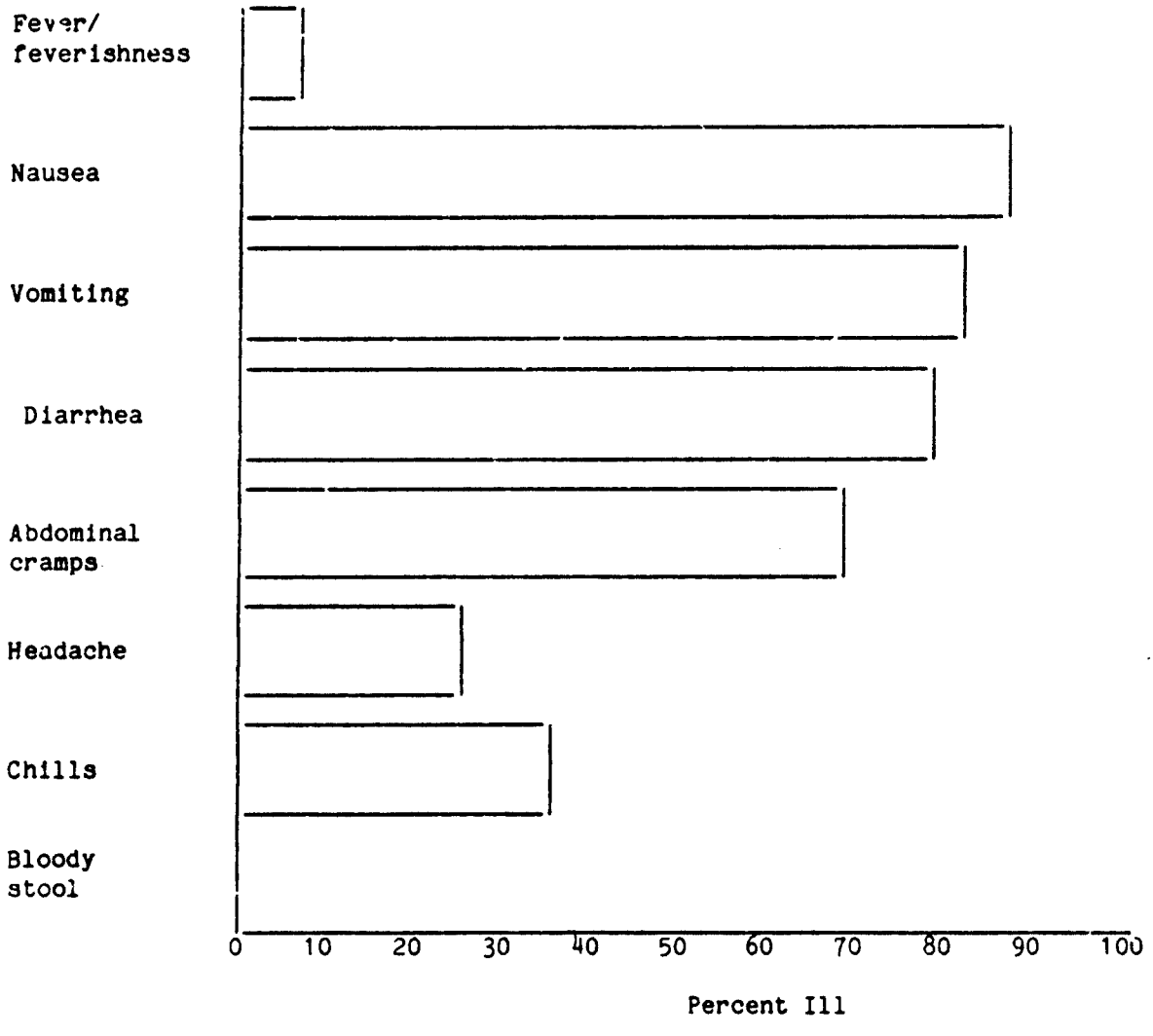

Figure 1. Composite profile of symptom complex for the etiologic agent *Staphylococcus aureus*.

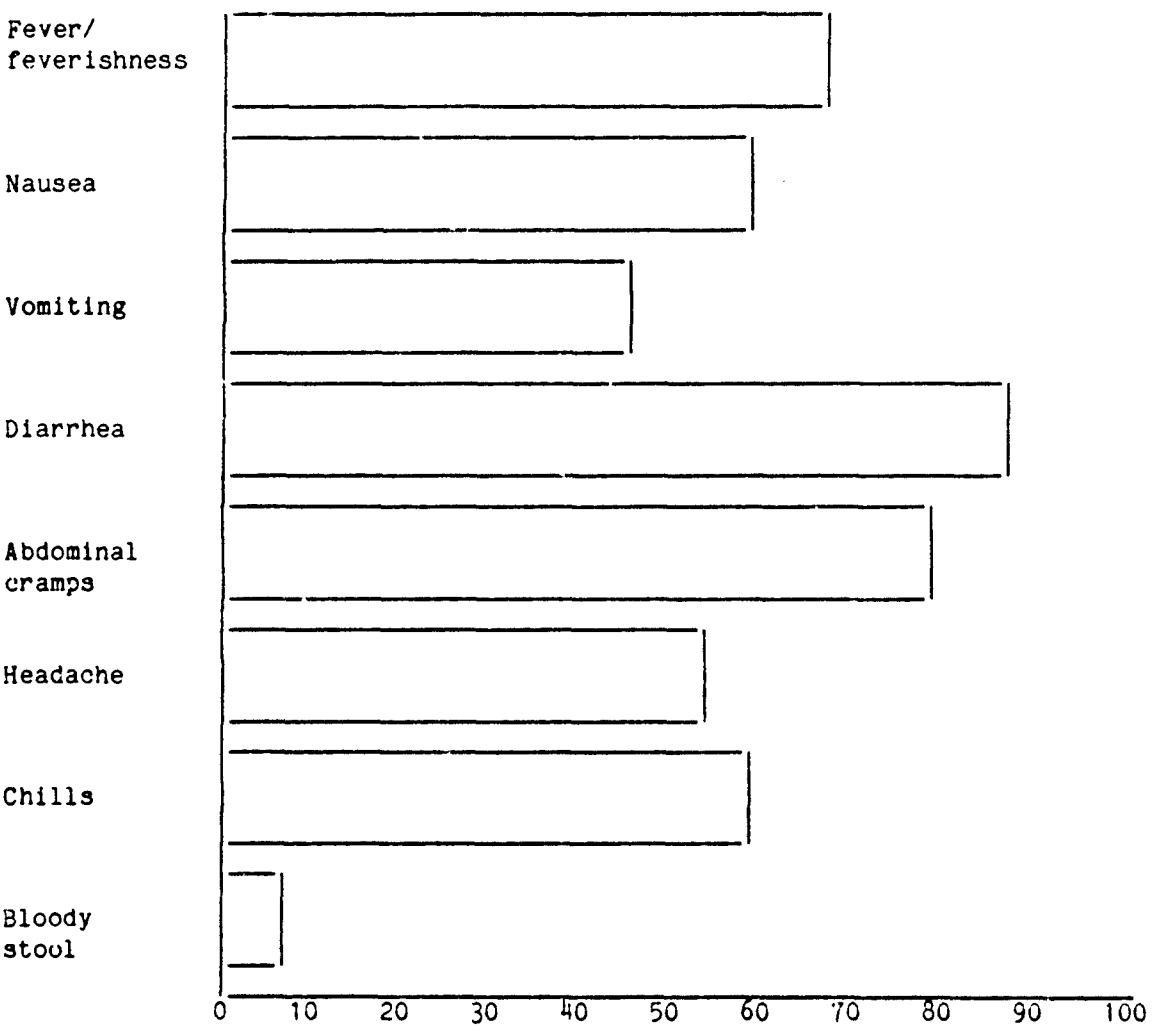

Figure 2. Composite profile of symptom complex for the etiologic agent *Salmonella*.

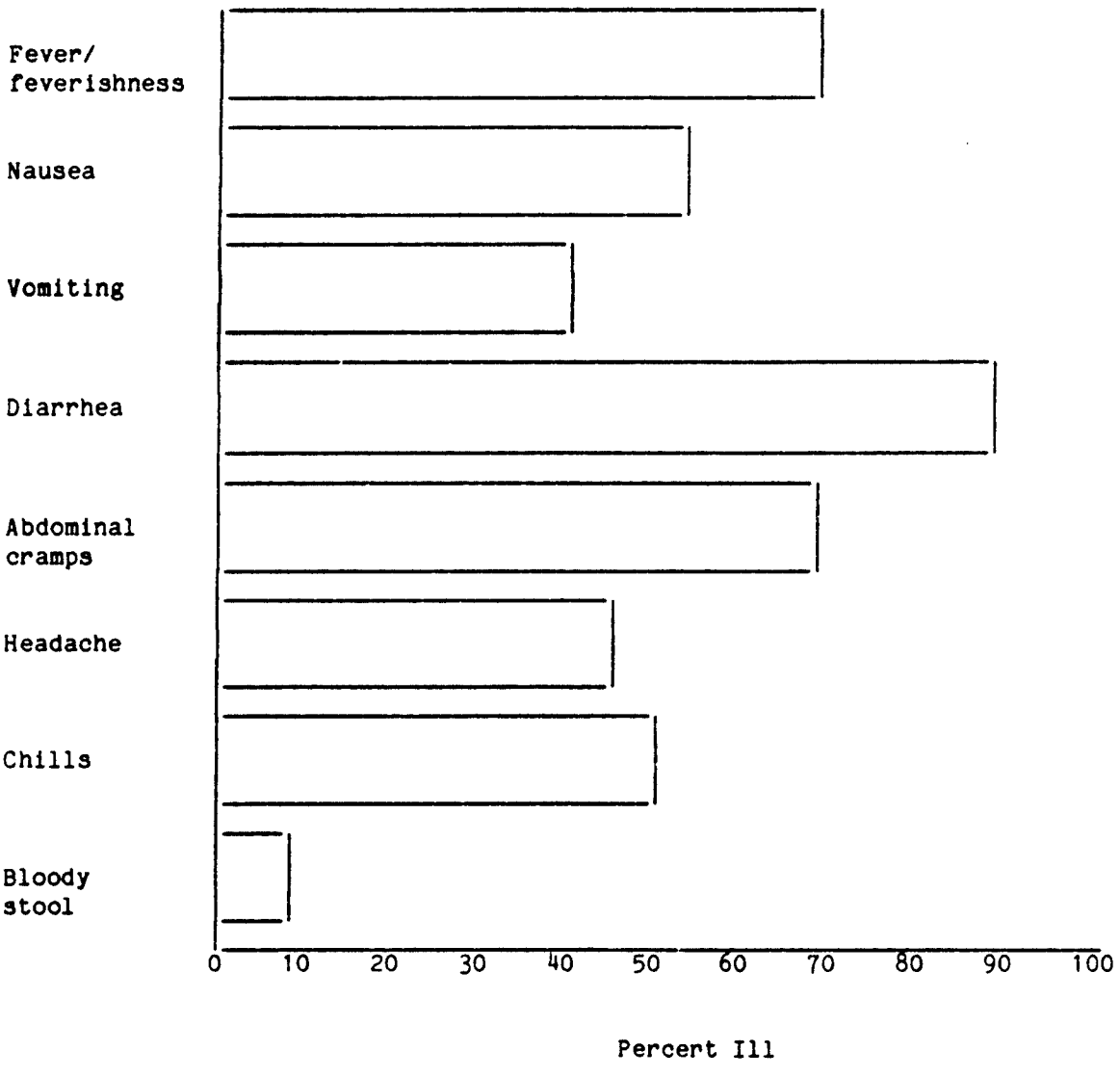

Figure 3. Composite profile of symptom complex for the etiologic agent *Shigella* (foodborne).

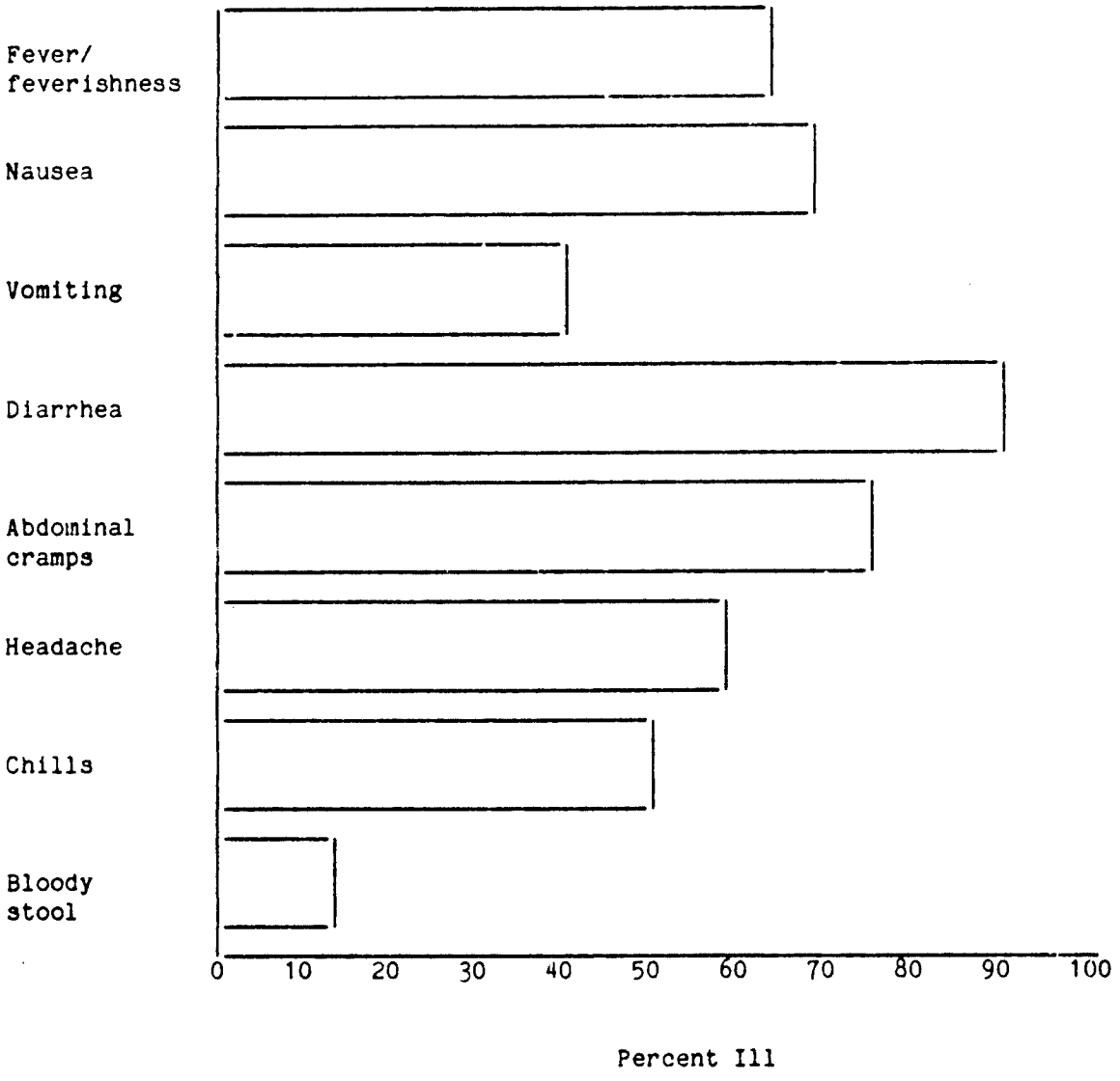

Figure 4. Composite profile of symptom complex for the etiologic agent *Shigella* (waterborne).

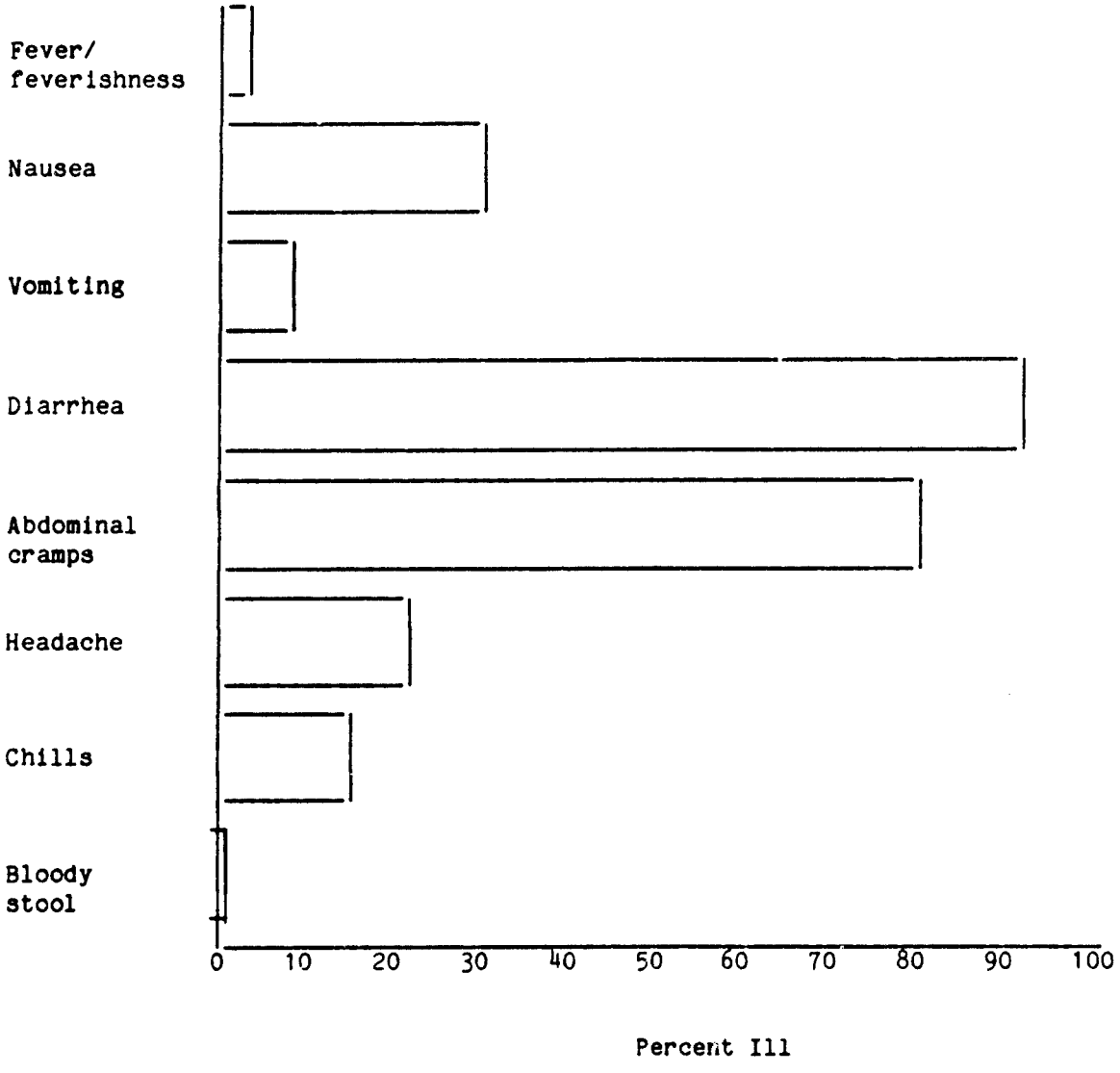

Figure 5. Composite profile of symptom complex for the etiologic agent *Clostridium perfringens*.

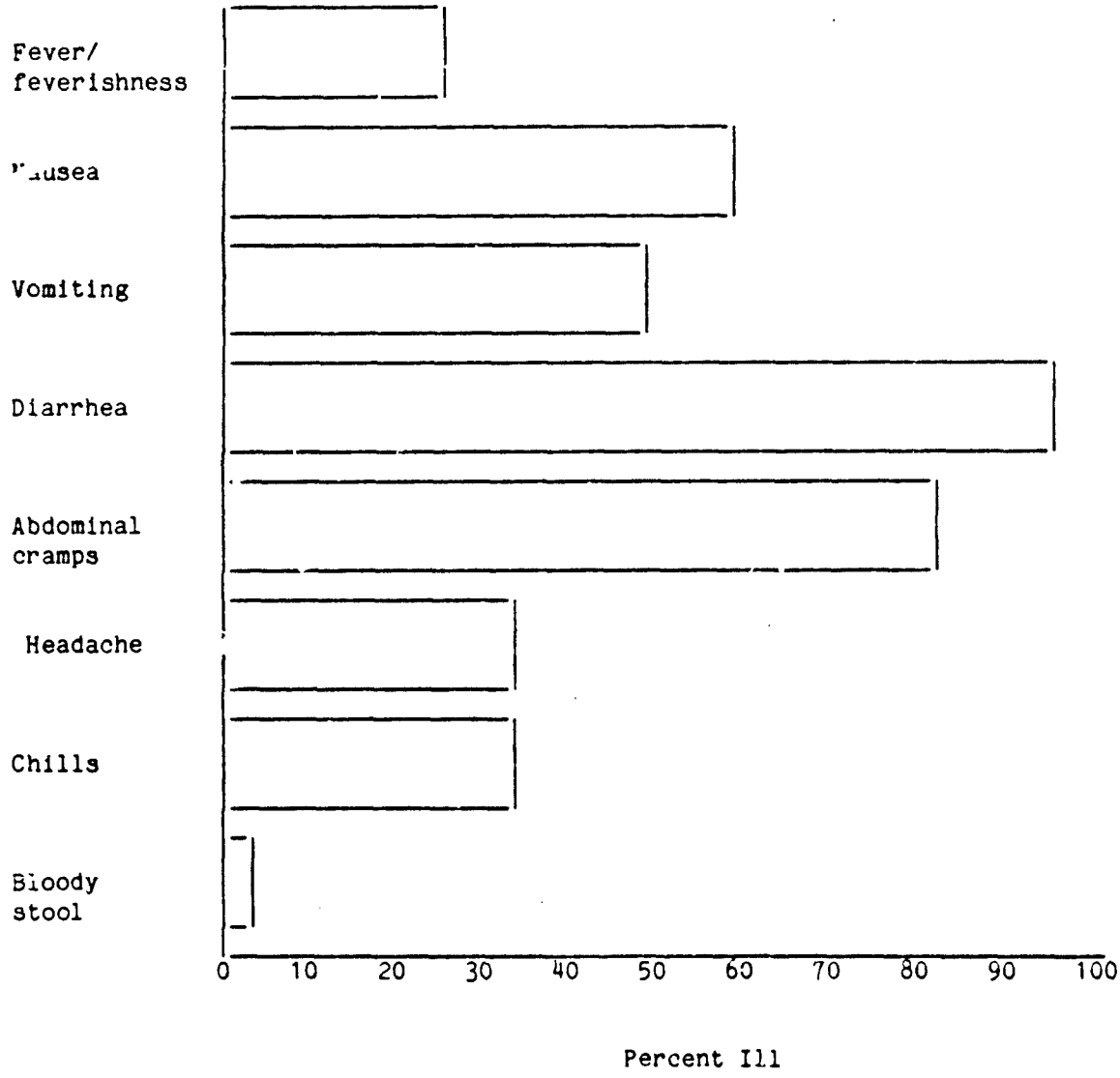

Figure 6. Composite profile of symptom complex for the etiologic agent *Vibrio parahaemolyticus*.

DISCUSSION

When an outbreak occurs without any marker symptoms to aid in diagnosing the etiology, the clinician might utilize the profiles presented here to note similarities between the current outbreak and an average composite of past outbreaks having a certain etiology. If properly interpreted, these profiles could supplement other sources of information and help in forming an initial, presumptive diagnosis of a most probable etiologic agent.

The profiles might be used in the following manner. First, for each of the eight symptoms that make up the profile, calculate the percentage of ill people having that symptom. Second, graph the eight percentages, using the same format as shown in Figures 1-6. Finally, visually compare the overall symptom complex of the outbreak and that of each of the profiles. Any etiology whose profile closely resembles the profile of the outbreak should be seriously considered; however, under no circumstance should an investigator just select the etiology with the closest profile and base all subsequent actions solely on this decision, disregarding any additional information. The fallacy of such an approach stems from the fact that the profiles were developed on, at best, incomplete information and do not show the variability between outbreaks or the relationships between symptoms within etiologies.

Considering the range of values obtained from the different outbreaks (Table 8), the profiles will usually indicate that a given symptom complex is reasonably close to the composite complex of several etiologies. In such cases, the relationships between symptoms may reflect entirely different patterns within each etiology and thus become the key to distinguishing between etiologies. Since the profiles, however, contain no information on such relationships, the clinician must neither fail to consider all profiles that resemble the outbreak nor rely too heavily on the profiles that are considered. Any conclusions drawn from the profiles are strictly subjective and will help only to provide some initial direction to the investigation.

RECOMMENDATIONS

Outbreak data as presently reported in the literature is not suitable for refined statistical analysis. Most reported outbreaks do not contain quantifiable data; and those that do, present no information about combinations of symptoms. A major upgrading of outbreak reporting procedures must be implemented in order for 1) data to be comparable from outbreak to outbreak, and 2) refined statistical analysis to be performed on the data. Such an upgrading is not likely until organizations that have the responsibility of collecting, reviewing, and reporting outbreak information agree to a common set of procedures to follow for all investigations of this type. Some obvious improvements might be the following:

1. Adopt a standard minimum set of symptoms to be reported for all investigations. Report zero values for all undetected symptoms.

2. Report observed relationships between symptoms. This might be done either by listing all observed symptoms for each ill person or by generating a summary frequency table for all possible combinations of symptoms.

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